

Table 4-130. Carbon tetrachloride data for perched water samples in Wells USGS-92, 8802D, and D10 at the Subsurface Disposal Area.

Perched Water Well	Depth (ft)	Concentration ($\mu\text{g/L}$)	Date
USGS-92	214	1,200	October 1987
		1,400	April 1988
		2,400	April 1992
		2,100	October 1992
		20	April 1997
		100	August 1997
		31	February 1998
		260	March 1998
		14	March 1999
		291	April 2000
8802D	220	110	July 1989
		190	October 1992
		38	February 1998
D10	238	20	October 1992

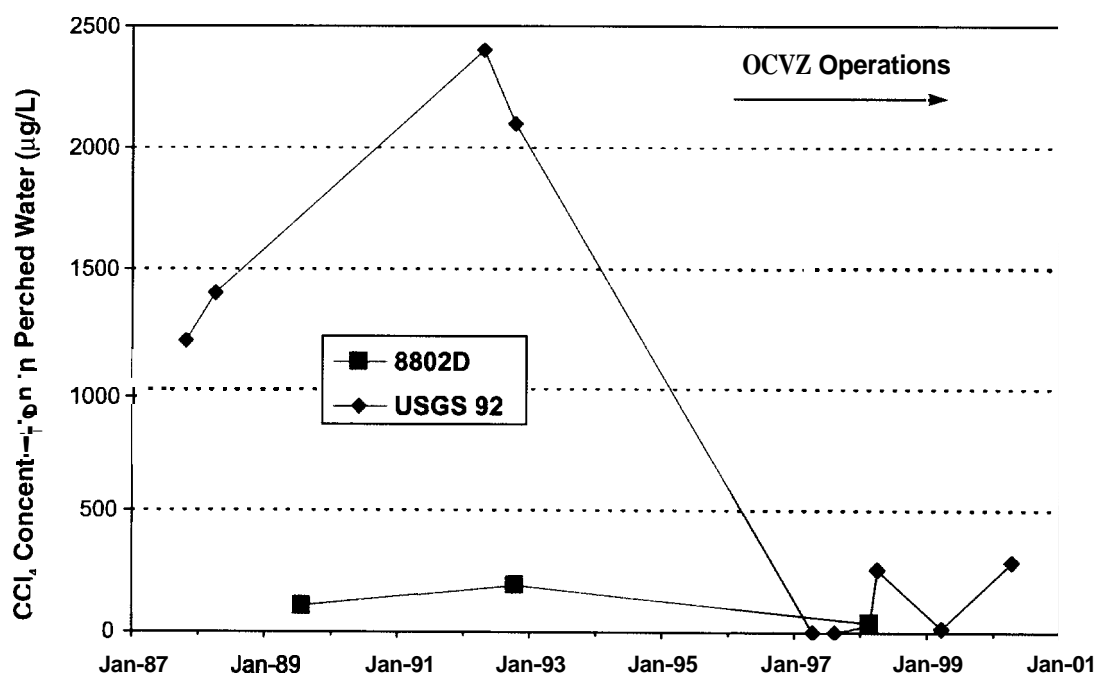


Figure 4-79. Carbon tetrachloride concentrations in perched water in Wells USGS-92 and 8802D.

4.8.1.3.5 Lysimeter Data—Carbon tetrachloride was detected in 11 of the 12 lysimeters sampled between 1997 and 2000 (not detected in 98-1L35). Maximum concentrations in each of the wells are shown in Table 4-131. The highest concentrations were detected in Wells PA01-L15, PA02-L16, and D06-DL02, which are near the north-central portion of the SDA at a depth of 4.4 m (14.3 ft), 2.7 m (8.7 ft), and 13.4 m (44 ft), respectively. Lysimeter locations are shown in Figures 4-8 and 4-9.

Table 4-131. Maximum carbon tetrachloride concentrations for the 11 lysimeters with carbon tetrachloride detections.

Lysimeter	Depth (ft)	Concentration (µg/L)	Date
D06-DL02	44	1,000	April 1997
PA01-L15	14.3	900	December 1998
PA02-L16	8.7	1,000	August 1997
98-5L39	10.5	1.9	August 1998
W05-L26	6.7	19	November 1998
W06-L27	11.8	30	August 1997
W08-L13	11.3	130	April 1997
W08-L14	6.2	73	April 1997
W23-L08	11.8	37	August 1998
W23-L09	7.7	30	August 1997
W25-L28	15.5	110	August 1997

4.8.7.4 Aquifer. The first VOC analyses for the aquifer beneath the INEEL were performed in 1987 as part of a reconnaissance survey by the USGS. Since that time, low levels of CCl₄ have consistently been detected in 16 of the 24 aquifer wells in the vicinity of the SDA that are or have been monitored for VOCs. Concentrations range from nondetect (less than 0.21 µg/L) to a maximum concentration of 8 µg/L measured in Well M7S during consecutive quarters in 1999. Concentrations in seven of the 24 wells have exceeded the MCL of 5 µg/L at least once. Concentrations in five wells currently exceed or are near MCLs. Table 4-132 contains a summary of the CCl₄ results as well as the maximum CCl₄ concentrations measured in SDA-vicinity wells. Maximum concentrations are shown in Figure 4-80 using a bubble plot.

Figure 4-81 shows the transient behavior of CCl₄ in 20 of the 24 SDA-vicinity aquifer wells. All of the wells where CCl₄ has been detected are shown on the map with the exception of Wells M11S and M13S. Only one sample from each of those two wells has been above the detection limit and both were estimated concentrations assigned a data qualifier (J flag).

One of the most noteworthy and surprising features of the CCl₄ distribution is the contrast in concentrations between wells close to the SDA and wells farther away from the SDA. All of the five wells shown in Figure 4-81 that are currently nondetect for CCl₄ (Wells USGS-89, M1S, USGS-117, M4D, and USGS-119) are very close or relatively close to the SDA boundary. Furthermore, concentrations in Well M17S are also low despite being the only well inside the SDA and immediately below the strongest VOC source area. Conversely, some of the wells with the highest concentrations (Wells M7S, M16S, USGS-120, and A11A31) are located at considerably greater distances from the

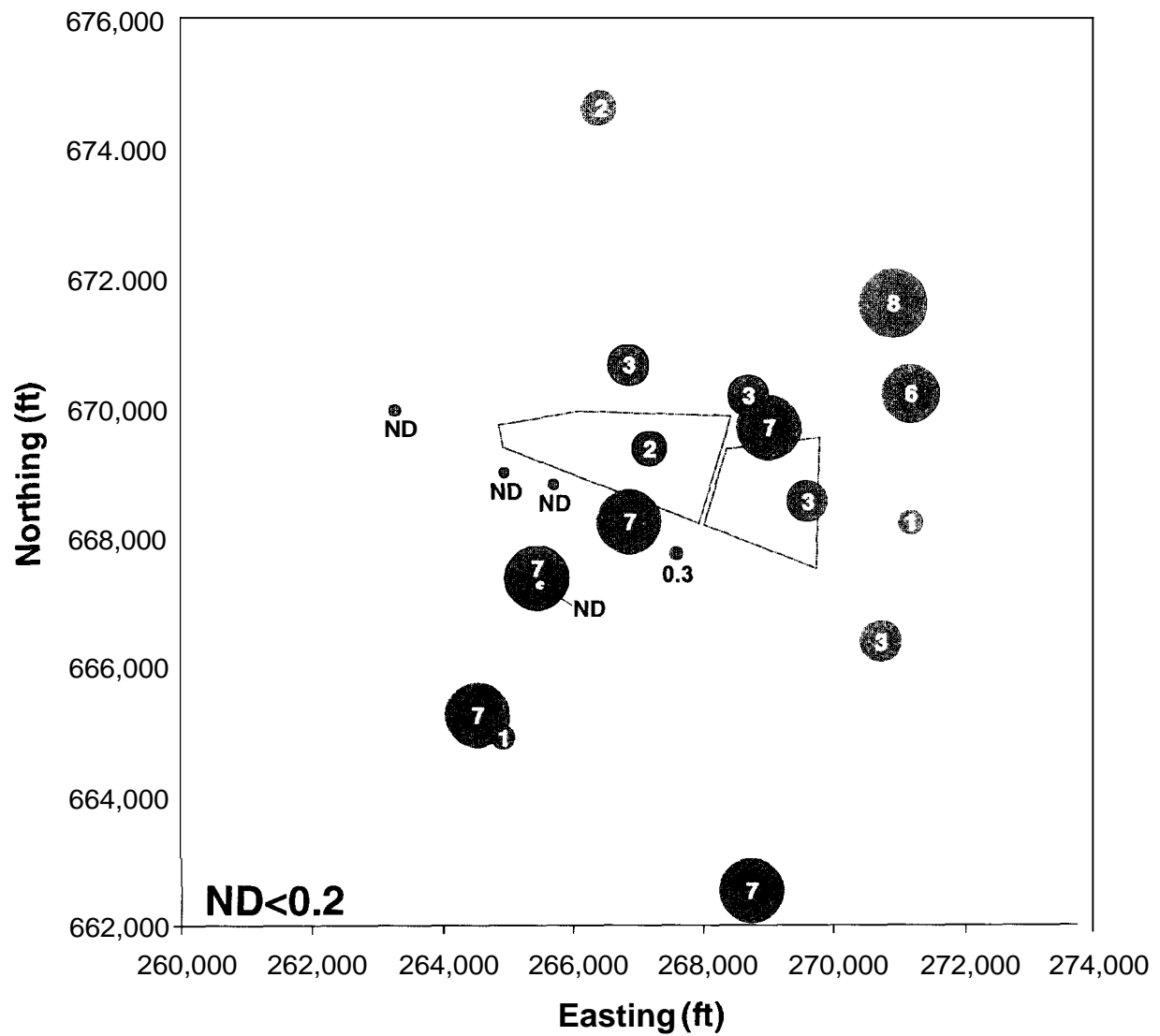


Figure 4-80. Bubble plot showing maximum carbon tetrachloride concentrations in aquifer in Subsurface Disposal Area vicinity monitoring wells.

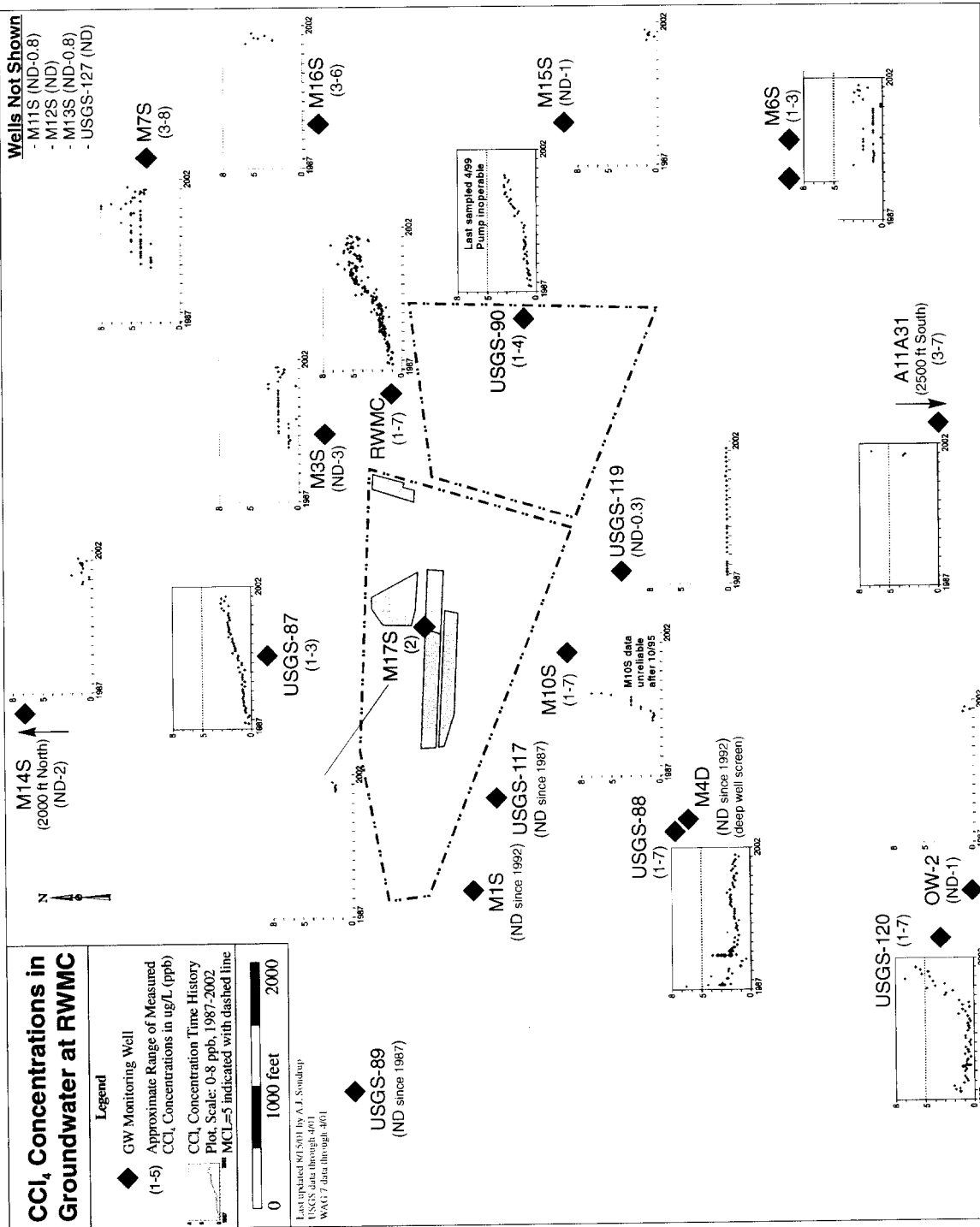


Figure 4-81. Carbon tetrachloride aquifer concentrations in monitoring wells in the vicinity of the Subsurface Disposal Area.

Table 4-132. Summary of carbon tetrachloride data from aquifer monitoring wells in the vicinity of the Subsurface Disposal Area.

Status of Wells (number of wells)	Well Names
Wells monitored for CCl ₄ in vicinity of the Subsurface Disposal Area (24)	M1S, M3S, M4D, M6S, M7S, M10S, M11S, M12S, M13S, M14S, M15S, M16S, M17S, OW-2, A11A31, RWMC Production Well, and USGS-87, -88, -89, -90, -117, -119, -120, -127
Wells with positive detects for CCl ₄ (15)	M3S, M6S, M7S, M10S, M14S, MISS, M16S, M17S, OW-2, A11A31, RWMC Production Well, and USGS-87, -88, -90, -120
Wells with nondetections for CCl ₄ (9)	M1S, M4D, M11S ^a , M12S, M13S ^a , and USGS-89, -117, -119 ^a , -127
Wells with CCl ₄ concentrations historically exceeding the MCL (7)	M7S, M10S, M16S, A11A31, RWMC Production Well, and USGS-88, -120,
Wells with CCl ₄ concentrations currently exceeding the MCL (5)	M7S, M16S, A11A31, RWMC Production Well, and USGS-120,
a. Only one result per well above minimum detection limit (J flag)	

SDA. In fact, of all the wells currently measuring concentrations above detection limit, Well A11A31 is the farthest from the SDA (approximately 1 mile) and yet has the highest current concentration (7 µg/L). The low concentration in many of the wells close to the SDA is probably because the wells are located in a low permeability zone. Otherwise, the concentration in wells near the SDA should be higher, based on vadose zone monitoring.

For wells with sufficient data to determine a trend, concentrations are either increasing or constant. Concentrations steadily increased for many years in Wells USGS-87, USGS-90, M3S, M7S, and the RWMC Production Well. However, the past few years show a relatively flat trend in concentration in these wells. These wells are to the north or east of the **SDA**. Other wells exhibiting flat concentration trends are Wells USGS-88, M6S, and M14S. Concentrations in Well USGS-120 were flat for several years until they recently began to increase rather dramatically. In terms of historic increases, the rise in concentration in Well M10S is possibly the most remarkable, increasing from 1 to 7 µg/L in a period of two years from 1993 to 1995. Concentrations measured for several years after 1995 in Well M10S were below the detection limit, but the data are not reliable because steel tapes were dropped in the well in late 1995 and 1998. Iron from the disintegrating tapes may have acted as a catalyst in degrading CCl₄, thus, diminishing the concentrations. Concentrations in the other wells (M15S, M16S, M17S, OW-2, and A11A31) appear to be steady, but the period of data collection is insufficient for making such a determination.

4.8.2 Tetrachloroethylene

Tetrachloroethylene is a manufactured chemical that is widely used for dry cleaning of fabrics and for metal degreasing. Like CCl₄, PCE can exist as a non-aqueous phase liquid, a vapor phase in the soil gas, an aqueous phase dissolved in soil water, and a solid phase sorbed onto soil particles. Tetrachloroethylene does not occur naturally in the environment; therefore, the true background concentration in any medium should be zero.

Tetrachloroethylene has been detected at the SDA in surficial sediments, vadose zone soil gas, vadose zone soil water (perched water and lysimeters), and groundwater. Tetrachloroethylene vapor has also been detected emanating from the soil surface by surface isolation flux chambers. The primary source of PCE at the SDA is 743-series waste. An examination of PCE contaminant data shows the distribution and trends are similar to CCl₄ data, but PCE concentrations are much less as a result of the smaller inventory. The distribution and trends are similar because both contaminants come from the same waste stream and because they have similar chemical and transport properties. The two contaminants are also similar from a toxicological standpoint. Because of these similarities, and because CCl₄ data are described extensively in Section 4.8.1, this section is a limited presentation of PCE data.

4.8.2.1 Waste Zone. Approximately 9.8E+04 kg of PCE has been buried in the SDA (Table 4-133). Varvel (2001) calculated the amount of PCE in 743-series waste by assuming the non-CCl₄ fraction of volatile organic compounds reported by Miller and Varvel (2001) contained equal volumes of PCE, TCE, and 1,1,1-TCA. The 743-series waste was buried in Pits 4, 5, 6, 9, and 10 (see Figure 4-67).

Table 4- 133. Waste streams containing tetrachloroethylene.

Waste Stream Code	Waste Stream Description	Mass (kg)	Proportion of Total Mass
RFO-DOW- 15H	Organic sludge	9.8E+04	100.0
Total Disposals		9.8E+04	100

4.8.2.2 Vadose Zone. Tetrachloroethylene has been detected in vadose zone soil gas, and in perched water and lysimeter samples. The PCE results are consistent with the CCl₄ results in that they are generally less than the CCl₄ results by the ratio of the inventories. The PCE inventory is approximately an order of magnitude less than the CCl₄ inventory and the PCE sample results are less than the CCl₄ results by about the same margin. As a result, many of the PCE sample results are less than detection limits in areas where the CCl₄ concentrations are low.

4.8.2.2.1 Soil Gas Data— Tetrachloroethylene has been detected in the soil gas from land surface to the aquifer. The maximum PCE soil gas concentration measured inside the SDA is 135 ppmv in Well 8902 Port 4 at a depth of 39 m (130 ft) on January 4, 1996. This compares to a maximum CCl₄ soil gas concentration of 4,864 ppmv in Well 9302 Port 6 at a depth of 23 m (77 ft). Since April 1998, the PCE concentrations in Well 8902 Port 4 have been less than 10 ppmv. The reduction in concentration is attributed to operation of the OCVZ remediation system. Concentrations at other wells inside the SDA are generally less than 20 ppmv. Inside the SDA below the C-D interbed, concentrations are less than 2 ppmv. This, however, is based on data from one location because the only soil gas sampling wells inside the SDA with sampling ports below the C-D interbed are Wells DE-1 and M17S, and they are very near each other.

The highest PCE concentration measured in soil gas outside the SDA is 75 ppmv in Well 77-1 Port 2 at a depth of 58 m (190 ft). Concentrations in this port are currently less than 30 ppmv. Outside the SDA below the C-D interbed, the maximum PCE concentration measured is 2.98 ppmv in Well 78-4 Port 2 at a depth of 76 m (251 ft). By far the majority of sample results in this region are less than 1 ppmv.

4.8.2.2.2 Perched Water Data— Tetrachloroethylene has been detected in perched water samples from Wells USGS-92, 8802D, and D 10 located inside the SDA. The highest concentration, 230 µg/L, was detected in Well USGS-92 in 1989. For comparison, the maximum CCl₄ concentration was

2,400 µg/L measured in the same sample. The maximum PCE concentration is less than CCl₄ by about one order of magnitude.

Like CCl₄, PCE concentrations in perched water have decreased in response to operation of the OCVZ remediation system. This can be seen in Table 4-134, which contains PCE concentrations measured in perched water over time. Before OCVZ operations began in 1996, PCE concentrations in Well USGS-92 ranged from 110 to 230 µg/L. Results from the last four samples taken from February 1998 to April 2000 have been less than or equal to 50 µg/L. Well 7V, an OCVZ vapor extraction well, is located near Well USGS-92.

Table 4-134. Tetrachloroethylene data for perched water samples at the Subsurface Disposal Area.

Perched Water Well	Depth (ft)	Concentration (µg/L)	Date
USGS-92	214	110	October 1987
		120	April 1988
		230	August 1989
		180	April 1992
		110	April 1997
		26	April 1997
		81	August 1997
		5.4	February 1998
		50	March 1998
		23	March 1999
		43	April 2000
8802D	220	7	July 1989
		13	October 1992
		2.6	February 1998
D10	238	4.5	October 1992

4.8.2.2.3 Lysimeter Data—Tetrachloroethylene was detected in six of the 12 lysimeters sampled between 1997 and 2000. Lysimeters with positive detections include Wells W23-L08, W23-L09, W25-L28, D06-DL02, PA01-L15, and PA02-L16. The maximum PCE concentration measured was 27 µg/L at Well W23-L08 at a depth of 3 m (11 ft) on August 3, 1998. For comparison, the maximum CCl₄ concentration in a lysimeter was 1,000 µg/L in Wells D06-DL02 and PA02-L16. Lysimeter locations are shown in Figures 4-8 and 4-9.

4.8.2.3 Aquifer. Positive detections of PCE in SDA-vicinity aquifer wells are infrequent. The maximum PCE concentration measured was 0.4 µg/L in Well M7S on five different occasions from 1993 to 1996. This is well below the MCL of 5 µg/L. For comparison, the maximum CCl₄ concentration measured was 8 µg/L also in Well M7S. Again, the PCE results for groundwater are less than the CCl₄ results by approximately an order of magnitude.

4.8.3 Methylene Chloride

Methylene chloride (dichloromethane) is an ingredient in many industrial compounds including solvents, paint and varnish removers, degreasing agents for metal parts, aerosols, refrigerants, and also is used as a blowing agent in foams. Methylene chloride contamination can exist in various forms including a non-aqueous phase liquid, a vapor phase in the soil **gas**, an aqueous phase dissolved in soil water, and a solid phase sorbed onto soil particles. Methylene chloride does not occur naturally in the environment; therefore, the true background concentration in any medium should be zero.

4.8.3.1 Waste Zone. About 1.41E+04 kg of methylene chloride was disposed of in the SDA (Table 4-135). Information about the methylene chloride disposal record is scant compared to that for CCl₄, the most prevalent VOC. It should be noted that CCl₄ can degrade to methylene chloride, thus, considering the large mass of CCl₄ buried in the SDA, detections of methylene chloride in samples may not necessarily be related to the original inventory disposed of in the SDA.

Table 4-135. Waste streams containing methylene chloride.

Waste Stream Code	Waste Stream Description	Mass (kg)	Proportion of Total Mass (%)
RFO-DOW-3H	Sludge	7.16E+03	51.2
RFO-DOW-4H	Paper, rags, and plastic	2.84E+03	20.3
RFO-DOW-9H	Trash	2.56E+03	18.3
RFO-DOW-12H	Dirt, concrete, ash, and soot	1.30E+03	9.3
Miscellaneous	Miscellaneous	1.40E+02	1.0
Total Disposals		1.40E+04	100

4.8.3.2 Surface. Methylene chloride is not analyzed as part of the INEEL's routine surface monitoring program.

4.8.3.3 Vadose Zone. Methylene chloride has been detected at low levels in the vadose zone. This section discusses the vadose zone sample results including: (a) soil gas data, (b) perched water data, and (c) lysimeter data.

4.8.3.3.1 Soil Gas Data—Several hundred soil gas samples have been collected and analyzed for methylene chloride; only five have returned positive detections. One of the samples was collected from Well TEM1-A in April 1993 at a depth of 0.61 m (2 ft). The other four samples were all collected from Well 8801 in September 1991. Two of the samples from Well 8801 were collected from Port 4 at a depth of 23.6 m (77.5 ft), and the other two samples were collected from Port 5 at a depth of 28.2 m (92.5 ft). Though the samples from Well 8801 were reported as positive detects, they should be viewed with caution because of high dilution factors. A summary of these results can be found in Table 4-136.

Table 4-136. Summary of positive detections of methylene chloride in soil gas samples collected near the Subsurface Disposal Area.

Well Name- Port	Sample Depth	Soil Gas Concentration (ppmv)	Dilution Factor ^a	Date
TEM 1A	2 ft	2	2	April 1993
8801-4	77.5 ft	70	400	September 1991
		184	400	September 1991
8801-4	92.5 ft	15	100	September 1991
		57	200	September 1991

a. Concentrations are adjusted for dilution factors. High dilution factors increase uncertainty in reported concentrations.

4.8.3.3.2 Perched Wafer Data—Three perched water samples have been collected from Well USGS-92, and one sample from Well 8802D, and analyzed for methylene chloride. The USGS-92 samples were collected on April and August in 1997 and February 1998. The April 1997 sample provided a statistically positive result for methylene chloride of 23 µg/L. The other two samples did not yield positive detections. The sample from Well 8802D was collected in February 1998, and was not statistically positive.

4.8.3.3.3 Lysimeter Data—Thirty-four lysimeter samples have been collected from Lysimeter Wells PA01-L15, PA02-L16, 98-1L35, 98-5L39, W05-L26, W08-L13, W08-L14, W23-L08, W23-L09, W25-L28, and D06-DL02 and subsequently analyzed for methylene chloride. The only sample to produce a statistically positive result for methylene chloride (6.8 µg/L) was collected from Lysimeter Well PA01-L15 on August 3, 1998. Lysimeter locations are shown in Figures 4-8 and 4-9.

4.8.3.4 Aquifer. Methylene chloride has been detected in 13 aquifer wells in the vicinity of the SDA that are or have been monitored for VOCs including USGS wells. Concentrations range from nondetect (less than 0.21 µg/L) to a maximum concentration of 8 µg/L measured in Well MIOS, collected on July 22, 1996. The MCL is 5 µg/L, and the risk-based water concentration is 7 µg/L. Table 4-137 contains a summary of the positive detections of methylene chloride. A large majority of the detections occurred during the same sampling round (July 1996), which raises the question whether the samples were cross-contaminated before or during analysis. Methylene chloride has not been detected in any aquifer wells since October 1997.

Table 4- 137. Summary of positive detections for methylene chloride in aquifer samples.

Aquifer Well	Concentration (µg/L)	Dilution Factor	Date
M1SA	6	1	February 1993
M1SA	5	1	October 1997
M3S	7	1	July 1996
M4D	5	1	July 1996
M6S	5	1	July 1996
M7S	5	1	July 1996
MIOS	8	1	July 1996

4.9 Contaminants of Ecological Concern

Fifty-nine WAG 7 contaminants of ecological concern were identified in the preliminary ecological contaminant screening (Section 3.4.2). Of those, 13 are also contaminants of concern to human health. Ecological risk assessments conducted at the INEEL are based on the evaluation and interpretation of the nature and extent of contaminants conducted for human health (VanHorn, Hampton, and Morris 1995). No WAG 7 samples have been collected and analyzed to specifically address ecological receptors, and sampling data were not analyzed in terms of nature and extent for individual ecological receptors (e.g., compared to ecologically based screening levels). However, INEEL sampling results and results from the Environmental Science and Research Foundation and the Radiological and Environmental Sciences Laboratory, were used to confirm the transport of contaminants from subsurface to surface soil, to locations outside the SDA, and into the food web. The data were also used to identify and substantiate the need for analyzing particular pathways of exposure.

Most surface and subsurface soil data were collected prior to re-contouring and alterations in the overburden thickness on the SDA (Becker et al. 1998). More recent soil sampling activities at the SDA have been limited. In addition, composite samples were generally collected for vegetation and tissue, and sampling locations are poorly documented. Collocated samples were not collected for all media (e.g., both vegetation and soil), so exposure factors and concentrations cannot be reconstructed from sampling results. Therefore, the DOSTOMAN model was used to generate concentrations across the SDA to allow evaluation of receptors in terms of a population-level exposure. The model incorporates subsurface to surface transport by plant root uptake and animal intrusion (see Section 5.4) and the sampling data are used as weight-of-evidence in the ecological risk assessment (ERA) (see Section 6.6). Only soil and food ingestion pathways were evaluated. No pathways to groundwater were identified for ecological receptors (see Section 6.6).

4.9.1 Radionuclides of Ecological Concern

Twelve radionuclide COPCs were identified in the preliminary contaminant screening (see Section 3.4.2) (see Table 4-138). Information about how and where biotic soil samples were collected is summarized in Sections 4.2 and 4.3. Results for individual COPCs are presented in the subsections designated in Table 4-139. Both surface and subsurface soil and biotic sampling conducted at the RWMC are discussed in each section.

In addition, sampling and analysis of soil, vegetation, and animal tissue have been conducted in and around the SDA by the Radiological and Environmental Sciences Laboratory (Peterson, Brewer, and Morris 1995) and the Environmental Science and Research Foundation. A summary of sampling results is given in Table 4-139.

Table 4- 138. Cross-references to nature and extent sections for radionuclide ecological contaminants of potential concern.

Contaminant of Potential Concern	Report Subsection
Am-241	(Section 4.6.2)
Am-243 ^a	Not applicable
Cm-244 ^a	Not applicable
Cs-137	(Section 4.6.6)
Nb-94	(Section 4.6.9)
Pu-238	(Section 4.6.13)
Pu-239/240	(Section 4.6.13)
Pu-242 ^a	Not applicable
Sr-90	(Section 4.6.17)
U-234	(Section 4.6.19)
U-238	(Section 4.6.19)

a. **This** contaminant is not a human health contaminant of potential concern.

Table 4- 139. Summary of radionuclide data collected in and around the Subsurface Disposal Area by the Radiological and Environmental Sciences Laboratory.

Contaminant of Potential Concern	Medium Concentration ^a (pCi/g)		
	Soil ≤ 10 cm Depth ^b	Vegetation ^c	Tissue (organism) ^d
Am-241	Not detected to 300' Not detected to 51' ^d	0.003 to 5.1'	Not detected to 38' (mammals) Not detected to 270' ^d (mammals) 0.022 ± 0.020 ^{c,h} (invertebrates)
Am-243 ^e	Not applicable	Not applicable	Not applicable
Cs-137	Not detected to 2.0' Not detected to 16' ^d	Not detected to 57'	Not detected to 6200' (mammals) Not detected to 130' ^d (mammals) Not detected to 4.0' (birds) 0.32 ± 0.21 ^{c,h} (snake) 0.46 ± 0.54 ^{c,h} (invertebrates)
Cm-244 ^e	Not applicable	Not applicable	Not applicable
Nb-94 ^e	Not applicable	Not applicable	Not applicable
Pu-238	Not detected to 1.4' Not detected to 2.6' ^d	Not detected to 0.057' ^d	Not detected to 8.9' (mammals) Not detected to 41' ^d (mammals) 0.0081 ± 0.011 ^{c,h} (invertebrates)
Pu-239/240	Not detected to 54' Not detected to 38' ^d	0.002 to 1.9' ^d	Not detected to 3.0' ^c (mammals) Not detected to 5.7' ^d (mammals) 0.078 ± 0.11 ^{c,h} (invertebrates)
Pu-242 ^e	Not applicable	Not applicable	Not applicable
Sr-90	Not detected to 4.6' Not detected to 26' ^d	Not detected to 160' ^d	Not detected to 3500' (mammals) 2.4 ± 3.2 ^{c,h} (invertebrates)

Table 4-139. (continued).

Contaminant of Potential Concern	Medium Concentration ^a (pCi/g)		
	Soil ≤ 10 cm Depth ^b	Vegetation ^f	Tissue (organism) ^g
U-234 ^c	Not applicable	Not applicable	Not applicable
U-238 ^e	Not applicable	Not applicable	Not applicable

a. Data reported in Peterson, Brewer, and Morris (1995).

b. Samples were collected at various locations at and near the Subsurface Disposal Area (SDA) between 1972 and 1985.

c. The range encompasses concentrations for all samples collected at the SDA.

d. The range encompasses concentrations for all samples collected at and beyond the SDA perimeter.

e. No samples have been collected and analyzed for this contaminant of potential concern.

f. Samples were collected at various locations at and near the SDA between 1976 and 1982.

g. Samples were collected at various locations at and near the SDA between 1978 and 1987.

h. Concentration does not meet the 3σ criterion for a positive detection (see Section 4.5.2).

4.9.2 Inorganics of Ecological Concern

Twenty-two inorganic COPCs were identified in the ecological screening (Hampton and Becker 2000) (Table 4-140). Soil samples have been collected on the SDA and analyzed for cadmium, copper, lead, manganese, mercury, and nitrates (Table 4-140). Soil samples have also been collected and analyzed for cadmium, copper, lead, and mercury (Table 4-140) as part of routine monitoring and special investigations conducted on the SDA by the Environmental Monitoring Group (LMITCO 1995a, Appendix F).

Table 4-140. Inorganics of ecological concern and soil sample analyses.

Contaminants of Potential Concern	Waste Area Group 7 ^a		Environmental Monitoring ^b	
	Number of Detects/ Number of Samples	Range (mg/kg)	Number of Samples	Range (mg/kg)
Aluminum nitrate	Not applicable	Not applicable	Not applicable	Not applicable
Asbestos	Not applicable	Not applicable	Not applicable	Not applicable
Beryllium oxide	Not applicable	Not applicable	Not applicable	Not applicable
Cadmium	25/79	0.7 to 2.3	NR	1.9 to 2.7
Copper (total)	71/79	9.6 to 34.6	NR	6.9
Lead	71/79	0.84 to 26	NR	8.8
Lithium hydride	Not applicable	Not applicable	Not applicable	Not applicable
Lithium oxide	Not applicable	Not applicable	Not applicable	Not applicable
Manganese	66/79	164 to 869	Not applicable	Not applicable
Magnesium oxide	Not applicable	Not applicable	Not applicable	Not applicable
Mercury (total)	6/88	0.11–14.3	Not reported	1.40–5,320'
Nitrates	see Section 4.7.1		Not applicable	Not applicable
Potassium chloride	Not applicable	Not applicable	Not applicable	Not applicable
Potassium hydroxide	Not applicable	Not applicable	Not applicable	Not applicable
Potassium nitrate	Not applicable	Not applicable	Not applicable	Not applicable
Potassium phosphate	Not applicable	Not applicable	Not applicable	Not applicable
Potassium sulfate	Not applicable	Not applicable	Not applicable	Not applicable
Sodium chloride	Not applicable	Not applicable	Not applicable	Not applicable
Sodium cyanide	Not applicable	Not applicable	Not applicable	Not applicable

Table 4- 140. (continued).

Contaminants of Potential Concern	Waste Area Group 7 ^a		Environmental Monitoring ^b	
	Number of Detects/ Number of Samples	Range (mg/kg)	Number of Samples	Range (mg/kg)
Sodium nitrate	Not applicable	Not applicable	Not applicable	Not applicable
Sodium phosphate	Not applicable	Not applicable	Not applicable	Not applicable
Sodium-potassium	Not applicable	Not applicable	Not applicable	Not applicable

Note: Bolded text indicates Contaminants for which soil samples have been collected and analyzed.

a. Data are contained in INEEL monitoring databases.

b. Sample analysis data were obtained from LMITCO (1995, Appendix F).

c. Detection resulted from breach of a disposal unit during drilling operations.

4.9.3 Organics of Ecological Concern

Twenty organic COPCs were identified in the preliminary ecological contaminant screening (Hampton and Becker 2000). No routine data for these COPCs have been collected. Most surface soil samples have been collected from areas near the Acid Pit and Pad A, and analyzed for seven of the twenty COPCs (shown in bold in Table 4-141). Sampling results for carbon tetrachloride and methylene chloride are presented in detail in Sections 4.8.1 and 4.8.2.

Table 4- 141. Summary of organics of ecological concern and Waste Area Group 7 soil sample analyses.

Contaminants of Potential Concern	Number of Detections/ Number of Samples	Range (mg/kg)
1,1,2-trichloro-1,2,2-trifluoroethane	Not applicable	Not applicable
3-methylcholanthrene	Not applicable	Not applicable
Alcohols	Not applicable	Not applicable
Carbon tetrachloride (see Section 4.8.1)	3/ 103	6 to -11
Chloroform	3/ 103	6 to -39
Dibutylethylcarbutol	Not applicable	Not applicable
Ether	Not applicable	Not applicable
Ethyl alcohol	Not applicable	Not applicable
Hydrofluoric acid	Not applicable	Not applicable
Methylene chloride (see Section 4.8.2)	60/ 103	7 to -139
Nitrobenzene	0/68	Not applicable
Nitric acid	Not applicable	Not applicable
Organophosphates (tributylphosphate)	1/68	590
Organic acids (ascorbic acid)	Not applicable	Not applicable
Sulfuric acid	Not applicable	Not applicable
Tetrachloroethylene	Not applicable	Not applicable
Trimethylpropane-triester	Not applicable	Not applicable
Toluene	2/ 103	23 to -28
Versenes (EDTA)	Not applicable	Not applicable
Xylene	0/ 103	Not applicable

EDTA = ethylenediaminetetraacetic acid

Note: Bolded text indicates contaminants for which soil samples have been collected and analyzed.

4.10 Nature and Extent of Contamination Summary

Thousands of samples have been collected in the proximity of the RWMC and in the SDA over the past 30 years, and many thousands of analyses have been performed. All the analytical data associated with the contaminants of potential concern at the RWMC and identified in the 1998 IRA were compiled and evaluated. The compilation encompasses analytical data from 1971 to 2001, and includes results generated by the DOE, the USGS, and the various INEEL contractors.

Some significant trends have been identified. In the aquifer around the RWMC, CCl_4 has been detected above MCLs, nitrate levels in the southeast corner of the SDA (M6S) are steadily increasing, and low concentrations of C-14 are reported. In addition, low concentrations of C-14, Tc-99, Am-241, uranium, and plutonium have been detected in the vadose zone, suggesting that migration from the waste zone is occurring. The highest density of detections seems to be located above the B-C interbed in the vadose zone; however, some contaminants have been detected at the C-D interbed, and CCl_4 extends to the aquifer.

4.10.1 Vadose Zone

Low concentrations of numerous contaminants have been detected in the vadose zone. Some data sets exhibit perceptible trends. Data indicate that CCl_4 , C-14, Tc-99, Am-241, and uranium and plutonium isotopes have been detected in the vadose zone beneath the SDA, and some are migrating both vertically and laterally. The main cluster of contaminants beneath the SDA seems to be located above the B-C interbed; however, some contaminants have been detected in the interval above the C-D interbed, and CCl_4 extends to the aquifer. Though concentrations in the vadose zone do not pose an imminent threat to the aquifer, the perceptible trends in the vadose zone indicate that some of these contaminants may ultimately impact the aquifer over time.

The evaluation of the analytical data from perched water, soil moisture and core samples has revealed four areas in the SDA vadose zone that contain the most prevalent number of contaminant detections. The areas are shown below (Figure 4-82), and are numbered and shaded in order of their relative detection rates (see Table 4-142). Carbon tetrachloride is not included in the analysis because it is detected in the vapor phase nearly everywhere in and around the SDA. However, a summary of CCl_4 contamination is included following the discussion of detection rates.

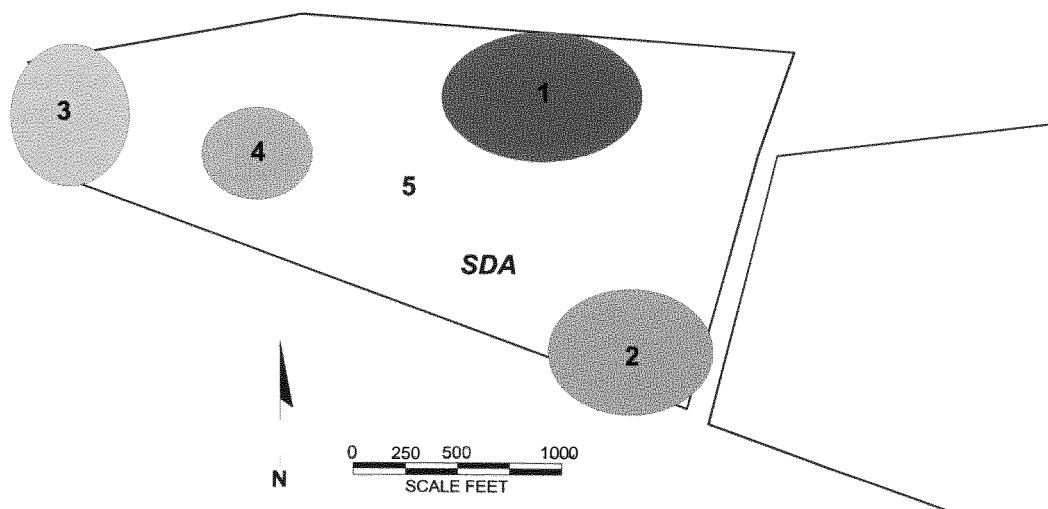



















































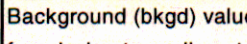
Figure 4-82. Areas with the most frequent statistically positive detections of contamination in the vadose zone.

Table 4-142. Detection rates for all contaminants of potential concern (except carbon tetrachloride) in the vadose zone within specified regions of the Subsurface Disposal Area.

Subsurface Disposal Area	1	2	3	4	5
Number of detections	303	62	131	103	54
Number of samples	998	355	947	1036	1053
Detection rate (%)	30	17	14	10	5
Detection rate ranking	1	2	3	4	5

Each identified SDA detection area also was ranked by the detection rate associated with selected contaminants in the vadose zone (see Table 4-143). This shows which contaminants are most prevalent in each SDA area. The magnitude of the detection rates are shown in Table 4-143 as shaded circles, with the darkest being the highest and lightest circles representing the lowest detection rate for all media in the vadose zone. The numbers shown below each shaded circle represent the actual number of detections versus the number of samples collected within each SDA detection area.

Table 4-143. Relative detection rate ranking for selected contaminants detected in the vadose zone.

Contaminant	Area 1	Area 2	Area 3	Area 4	Area 5
Am-241	 21/106	 0/36	 8/107	 6/127	 5/158
C-14	 6/41	 1/15	 1/29	 9/40	 0/13
Pu-238	 21/113	 0/36	 2/116	 5/135	 0/151
Pu-239/240	 19/115	 0/36	 1/120	 3/135	 2/157
Tc-99	 13/46	 1/19	 16/38	 3/39	 2/36
U-233/234 (>bkgd)	 68/83	 23/31	 32/61	 25/62	 8/47
U-235/236 (>bkgd)	 44/83	 4/31	 9/60	 1/62	 5/47
U-238 (>bkgd)	 69/83	 25/31	 33/64	 24/65	 9/50
Nitrates	 26/41	 3/9	 15/19	 12/17	 17/18
 = Detection Rate Ranking 1 (high rate of detection)  = Detection Rate Ranking 2 (medium rate of detection)  = Detection Rate Ranking 3 (low rate of detection)  = Detection Rate Ranking 4 and 5 (lowest rate of detection)  = Indicates areas with elevated uranium levels (>>background)					
Background (bkgd) values for lysimeter data are based on soil moisture sample results from lysimeter wells outside the SDA [ie., the "O" wells and the control well (D15)].					

Uranium detection rates in Table 4-143 are actually background exceedance rates and represent the number of samples exceeding a local background per total number of samples taken. Background values for the vadose zone cores were based on comparison to surface soil background concentrations reported by Rood, Harris, and White (1996) for U-234, U-235, and U-238. Background uranium concentrations in

soil moisture are not established, so were calculated from the soil moisture samples taken from lysimeters located outside the SDA (O-series wells) and from the lysimeter samples taken from well D 15 designated local background location. While the number of samples exceeding background appears high for uranium isotopes in the vadose zone, some of these exceedances appear to be within the normal range of variance for background. However, samples from Areas 1 and 3 (highlighted in Table 4-143) contain relatively high concentrations of uranium and appear to be truly above background.

The high mobility of uranium coupled with the emerging trends in the vadose zone may indicate migration from the SDA. Elevated concentrations of U-238 emerging at 88 ft, along with steadily high concentrations at 44 ft depth in well D06 (near Pad A) suggest that uranium is migrating in the vadose zone. In addition, preliminary indications from the ultra low-level uranium analyses suggest that man-made uranium (depleted and enriched) is also present in the perched water at about 220 ft deep. Additional wells with lysimeters at various depths could help to confirm if similar uranium trends are evident elsewhere in the SDA region. Periodic sensitive analysis with TIMS and continued interpretation of monitoring data could be used to validate or refute the emerging trends.

4.10.2 Aquifer

The contaminants detected in the aquifer are CCl_4 , nitrates, and C-14. Carbon tetrachloride and nitrates have been consistently detected in the aquifer around the RWMC area, and C-14 is detected near the SDA as well as 1 to 3 miles upgradient of the RWMC.

Carbon-14 is often seen with **H-3** and CCl_4 , and all three contaminants can travel in the vapor phase. The observed C-14 concentrations may emanate from the SDA or from an upgradient source. Currently, no trends in the data are apparent but C-14 monitoring should endeavor to verify the source of C-14.

The CCl_4 and nitrate concentrations in some wells show significant trends and several are near or slightly above the MCL. Nitrate levels in the southeast corner of the SDA (M6S) are steadily increasing; however, the concentration remains in the range typical of nitrate background values in groundwater. The cause of the increasing nitrate levels in this area of the SDA has not been determined, but nitrate is a common contaminant associated with farming and other activities not associated with the INEEL.

Plutonium and americium have not adversely impacted the aquifer. Only about 1% of the total number of aquifer samples collected and analyzed for plutonium and americium over the past 30 years are actual 3-sigma detections (i.e., 15 reliable and defensible detections out of 1,510 plutonium sample analysis, and 7 reliable and defensible detections of Am-241 out of 757 sample analyses). The detections of Pu-238 are two orders of magnitude below the $1\text{E-}05$ risk-based concentration for the aquifer. There were a couple of Pu-239/240 results in 1993 from M4D that were unusually high, but no detectable concentrations in that well since then. There were also a couple of unusually high Am-241 detections in well M1S in 1997 and 1998. The concentrations were between 1-2 pCi/L, which is below the $1\text{E-}05$ aquifer RBC of 4.58 pCi/L but much higher than positive detections in other wells (around 0.03 pCi/L). Subsequent analyses since 1998 have not indicated Am-241 presence. In general, the sporadic nature of the plutonium and americium detections precludes defensible conclusions about impacts to the aquifer below the RWMC. The detections are likely statistical anomalies associated with making analytical measurements near the detection limit, or are associated with randomly occurring particles.

Anthropic uranium, though present in the vadose zone, has not been detected in the aquifer. Calculated ratios from the ultra low-level TIMS analyses of aquifer samples indicate uranium in the aquifer is naturally occurring. Uranium concentrations in the aquifer from routine analyses appear to be within the normal range of background concentrations. In the following discussion and graphics, the

U-234 will appear elevated above background concentrations, which is likely an artifact of using background concentrations that are too low for the aquifer samples beneath the RWMC. Section 4.6.19 discusses how isotopic background concentrations were derived.

4.10.3 Integrated Assessment

This section uses three-dimensional illustrations to depict the combined monitoring results from the vadose zone and aquifer, and discusses these results. To better illustrate the extent and depth of the contaminants of potential concern detected in the SDA vicinity, some of the upgradient and downgradient aquifer wells were excluded from the figures. Each illustration shows the SDA outline at the surface, at the B-C interbed, the C-D interbed and at the top of the aquifer. Sample locations where no detections were observed are shown as white circles, and locations where positive detections were observed are shown as colored circles. The vadose zone data include both soil moisture (lysimeter and perched water) and vadose zone core sample results.

Figure 4-83 shows the locations of Am-241 detections and nondetections in the vadose zone and aquifer directly beneath the RWMC. Most positive detections in the vadose zone are associated with core samples. Few soil moisture samples from the vadose zone indicate the presence of Am-241, and aquifer detections are very few, suggesting that Am-241 has not migrated into the aquifer. The sporadic nature of Am-241 detections in the aquifer, the low detection rate, and the low detected concentration are not conclusive, but imply that Am-241 detections do not show a trend.

Figure 4-84 shows the locations of C-14 detections and nondetections in the vadose zone and aquifer directly beneath the RWMC. Most positive detections are associated with liquid samples from shallow and mid-depth lysimeters and the aquifer, but not with the vadose zone core samples or deep suction lysimeters. Carbon-14 is in the aquifer at low concentrations in the vicinity of the RWMC, however, there were several detections of C-14 in upgradient wells not shown in this figure. Carbon-14 may be migrating in the vadose zone, and has apparently migrated to the perched water at a depth of 67 m (220 ft). However, data are too sparse to clearly define the extent of C-14 movement in the vadose zone.

Figure 4-85 shows the locations of Pu-238 detections and nondetections in the vadose zone and aquifer directly beneath the RWMC. Plutonium detections in the vadose zone are numerous; however, most are associated with core samples, and only a few detections are associated with the soil moisture (lysimeter) samples. Significant quantities of plutonium do not appear to be moving in the vadose zone. However, a very small fraction may possibly be moving in the vadose zone at concentrations too low to be measured by the most sophisticated analytical technology available. Most of the Pu-238 detections in the aquifer are from the sampling event that took place in September and October 2000. The reliability of these data is questionable because of the absence of corresponding Pu-239/240 detections.

Overall, there is little evidence to show that there is extensive or widespread migration of Pu-238 in the vadose zone.

Figure 4-86 shows the locations of Pu-239/240 detections and nondetections in the vadose zone and aquifer directly beneath the RWMC. Most positive detections in the vadose zone are associated with core samples. Few soil moisture samples from the vadose zone indicate the presence of Pu-239/240. There is no extensive or widespread migration of Pu-239/240 in the vadose zone. The sporadic nature of Pu-239/240 detections in the aquifer and the low detection rate do not provide sufficient evidence to conclude that low levels of 1 - 239 are widespread in the aquifer beneath the RWMC.

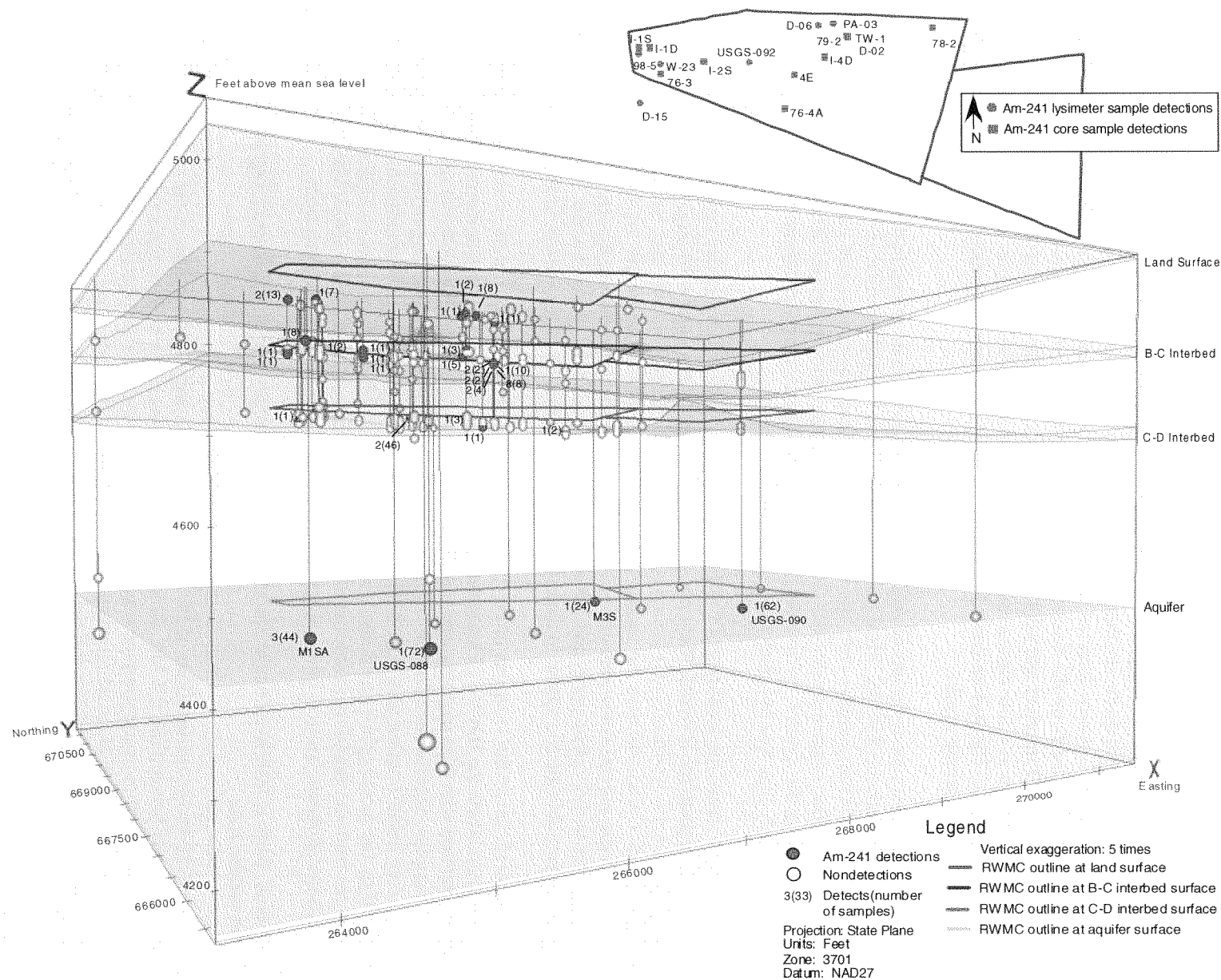


Figure 4-83. Americium-241 detections in the vadose zone and aquifer around the Subsurface Disposal Area.

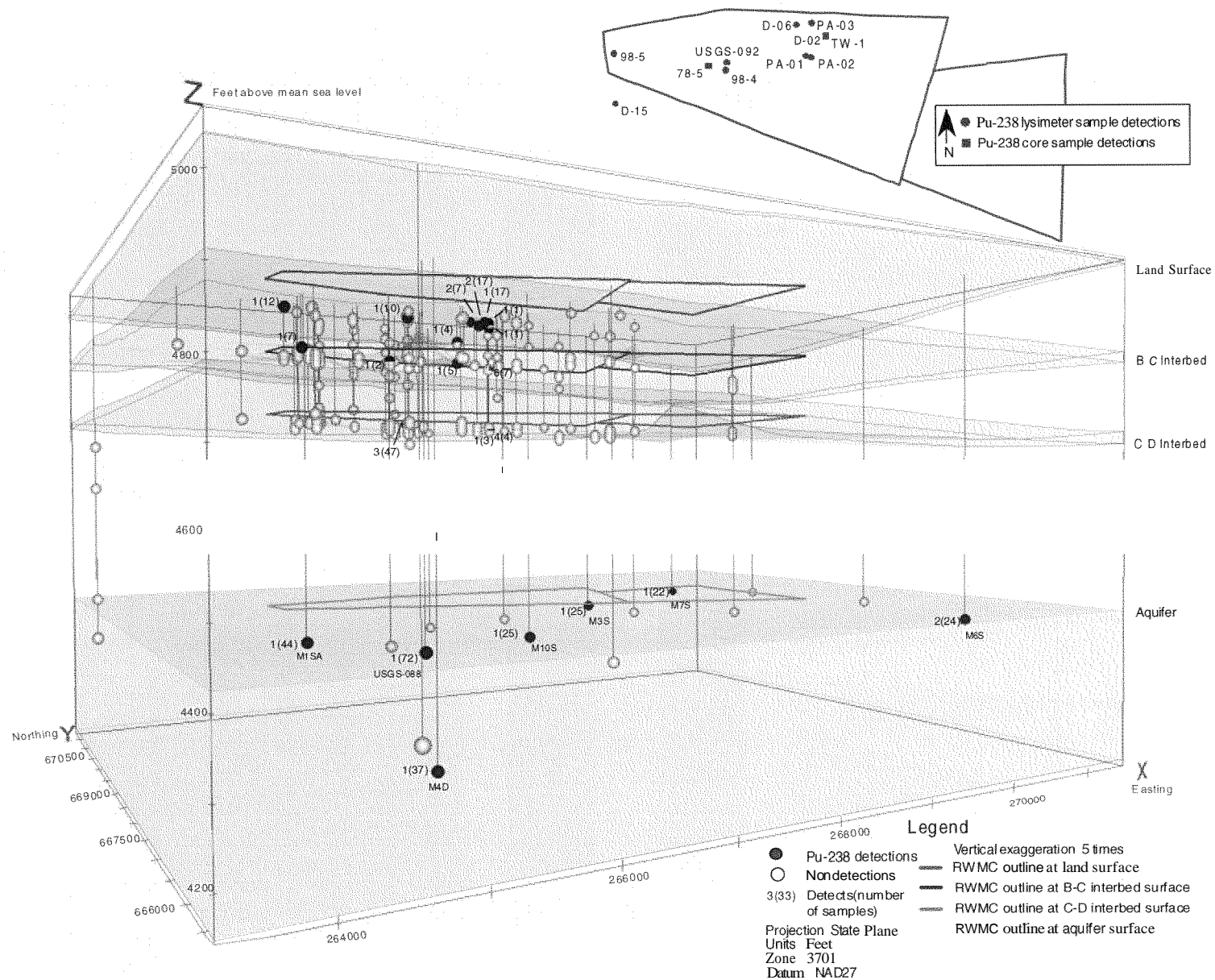


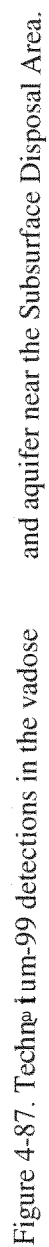
Figure 4-85. Plutonium-238 detections in the vadose zone and aquifer around the Subsurface Disposal Area.

Figure 4-87 shows the locations of Tc-99 detections and nondetections in the vadose zone and aquifer directly beneath the RWMC. Most positive detections in the vadose zone are from the core samples and soil moisture samples, suggesting that Tc-99 may be moving in the vadose zone. Technetium-99 was detected in all the I-series well core samples at the B-C and C-D interbeds and in soil moisture samples from the shallow lysimeters in SDA Areas 1 and 3. The sporadic nature of Tc-99 detections in the aquifer and the low detection rate do not provide sufficient evidence to conclude that low levels of Tc-99 are widespread in the aquifer beneath the RWMC.

Figure 4-88 shows the locations of U-233/234 detections above background concentrations in the vadose zone and aquifer directly beneath the RWMC. Most of the detections above background in the vadose zone are associated with the shallow and mid-depth lysimeters. Many of the measured U-234 concentrations only slightly exceed the average soil moisture background (3 pCi/L) and are likely to be characteristic of background concentrations. However, not enough soil moisture background data exist to establish a usable statistical interval. Many soil moisture results are much greater than U-234 background (i.e., approximately 4 to 30 times higher), and are primarily associated with SDA contamination Areas 1 and 3. Many of the low U-234 concentrations measured in the aquifer are only slightly above established and published groundwater background concentrations (1.1 pCi/L). The U-234 aquifer results are likely in the concentration range of normal background ranges.

Figure 4-89 shows the locations of U-235 detections above background concentrations in the vadose zone and aquifer directly beneath the RWMC. Most of the detections above background in the vadose zone are associated with the shallow and mid-depth lysimeters. Many of the measured U-235 concentrations only slightly exceed the average soil moisture background (0.5 pCi/L) and are likely to be characteristic of background concentrations. Not enough soil moisture background data exist to establish a usable background concentration range for soil moisture samples. Several soil moisture results are much greater than U-235 background (i.e., approximately 2 to 9 times higher), and are primarily associated with SDA contamination Areas 1 and 3. Many of the low U-235 concentrations measured in the aquifer are only slightly above established and published groundwater background concentrations (0.05 pCi/L). It is our opinion that all of the U-235 results associated with the aquifer beneath the RWMC are within the concentration range of normal background concentrations.

Figure 4-90 shows the locations of U-238 detections above background concentrations in the vadose zone and aquifer directly beneath the RWMC. Most of the detections above background in the vadose zone are associated with the shallow and mid-depth lysimeters. Many of the measured U-238 concentrations that only slightly exceed the average soil moisture background (1.5 pCi/L) are likely to be characteristic of background concentrations. However, not enough soil moisture background data exist to establish a usable statistical interval.



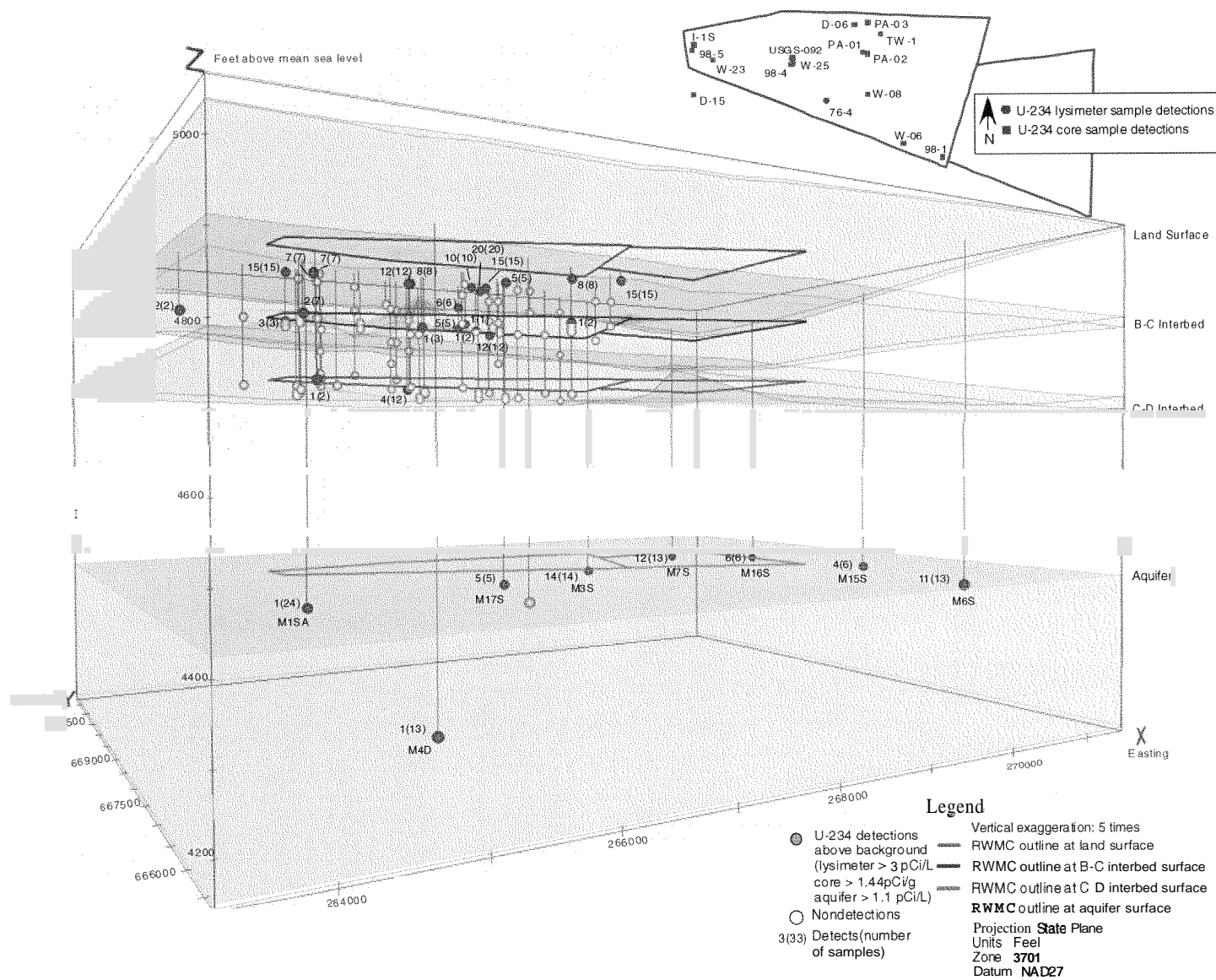


Figure 4-88. Uranium-233/234 detections in the vadose zone and aquifer near the Subsurface Disposal Area.

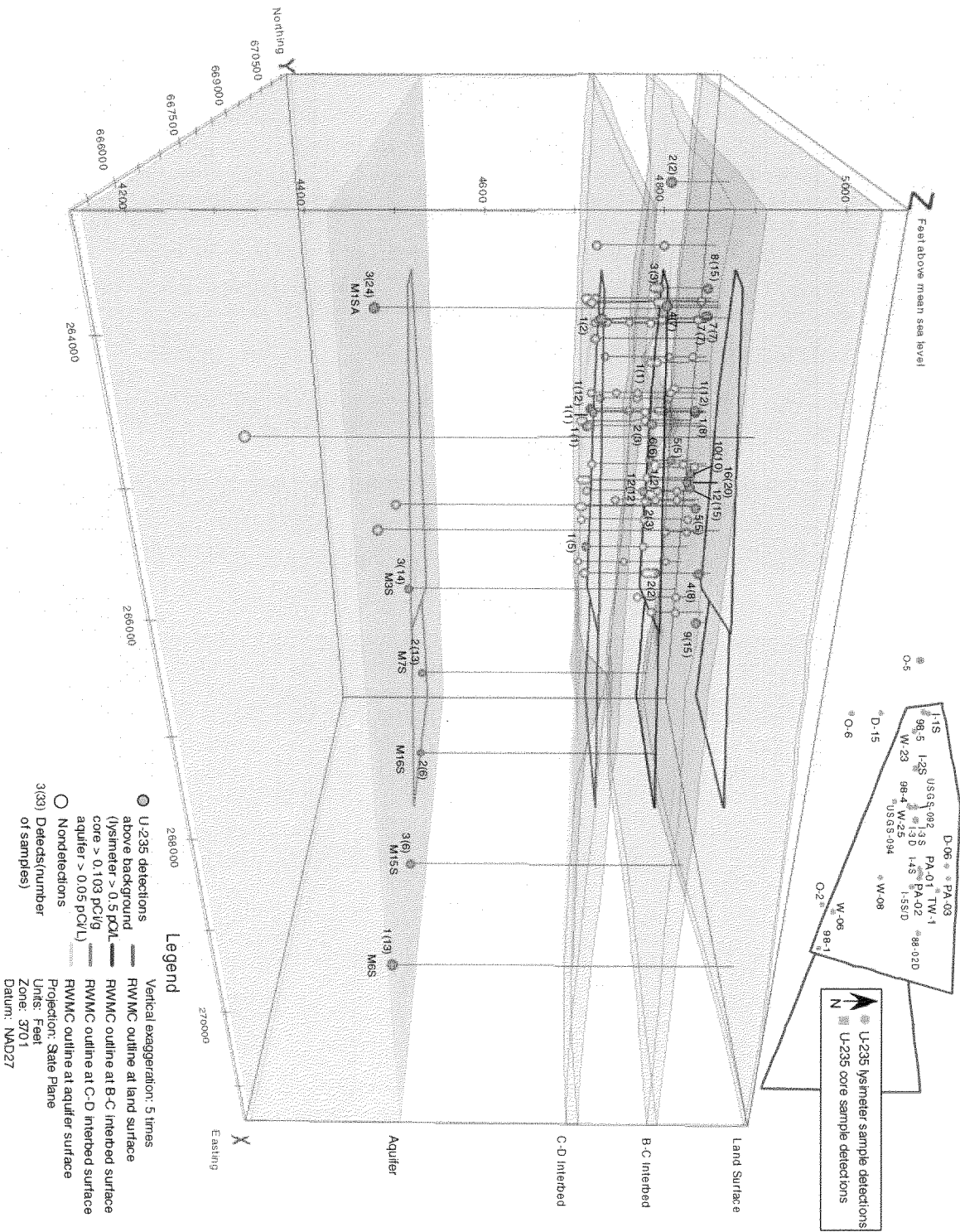


Figure 4-89. Uranium-235 detections above background in the vadose zone and aquifer near the Radioactive Waste Management Complex.

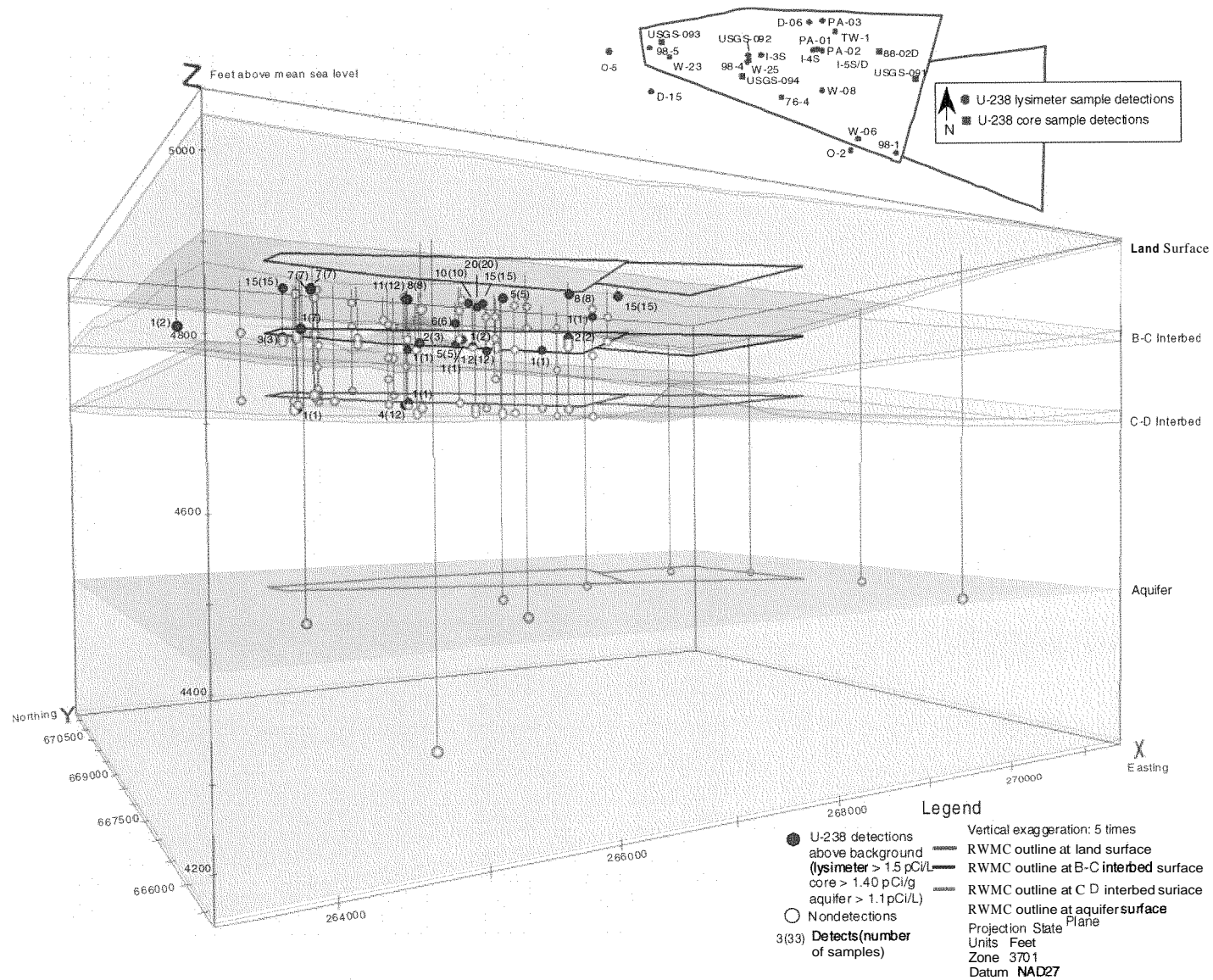


Figure 4-90. Uranium-238 detections in the vadose zone and aquifer around the Radioactive Waste Management Complex.

Table 4-144 identifies some of the general comments about each one of the Contamination areas. Many soil moisture results are much greater than the U-238 background (i.e., approximately 5 to 30 times higher), and are primarily associated with SDA detection Areas 1 and 3. Many of the low U-238 concentrations measured in the aquifer are only slightly above established and published groundwater background concentrations (1.1 pCi/L), and are likely within the concentration range of normal background concentrations.

Table 4-144. Summary of each contamination area at the Subsurface Disposal Area.

Subsurface Disposal Area	Summary
1	<p>Contains numerous contaminants in the vadose zone, most associated with actinides (uranium, plutonium, americium) and mobile activation and fission products (C-14 and Tc-99).</p> <p>C-14, Tc-99, and anthropic uranium may be moving in the vadose zone. C-14 detections in soil moisture samples from Lysimeter Well PA02 are accompanied by H-3 detections, which may indicate activated beryllium is buried in this area.</p> <p>Numerous detections of transuranic radionuclides are noted in the core data, but few detections or trends were observed in the soil moisture data.</p> <p>Lysimeter Well TW1 soil moisture samples show evidence of enriched uranium and perched water Well 8802D samples show evidence of depleted uranium.</p> <p>Waste buried in Pit 5 and Pad A appear to be the sources of contamination in Area 1</p>
2	<p>The main contaminant detected in this area is uranium.</p> <p>Tritium is also present at elevated concentrations in this area, and its source is thought to be the buried beryllium blocks in Soil Vault Row 20.</p>
3	<p>Contains Tc-99, nitrates, U-235 and Am-241 in the vadose zone.</p> <p>Uranium ratios suggest that anthropic uranium may be present.</p> <p>Numerous detections of americium are noted in the vadose zone core data. Few detections were observed in the soil moisture data.</p>
4	<p>The contaminants detected in this area are C-14 and plutonium.</p> <p>Most C-14 detections in this area are from the USGS-92 perched water well. C-14 may have migrated to the 220-ft perched water zone.</p>
5	<p>Sporadic and inconsequential concentrations detected throughout this general area.</p> <p>Detections in this general area are primarily from Well W08 (Acid Pit) and scattered vadose zone core samples.</p>

Table 4-145 summarizes the key issues and trends associated with each of the COPCs.

Table 4-145. Summary associated with each contaminant.

Contaminant	Summary
Am-241	<p>Most Am-241 detections are in Subsurface Disposal Area (SDA) Areas 1 and 3.</p> <p>Most detections are associated with vadose zone core samples.</p> <p>No noted trends.</p>
C-14	<p>Most detections in Area 1 are from shallow lysimeter Well PA02 (along with elevated H-3).</p> <p>C-14 may have migrated to the 220-ft perched water.</p>
Pu-238	<p>Most detections are associated with vadose zone core samples from SDA Area 1.</p> <p>No noted trends on core data.</p> <p>Possible trend developing in Area 1 (shallow lysimeter Well PA02).</p>
Pu-239/240	<p>Most detections are associated with vadose zone core samples from SDA Area 1.</p> <p>No noted spatial trends on core data.</p> <p>Possible trend developing in Area 1 (shallow lysimeter Well PA02).</p> <p>Results from thermal ionization mass spectrometry (TIMS) analysis of Pu-239 on filtered material from Wells PA03, TW1, and 8802D are statistically higher than all other sample results, further suggesting the possible presence of Pu-239 in the vadose zone of Area 1.</p>
Tc-99	<p>Numerous detections were obtained from both vadose zone core samples and lysimeter samples. The results suggest that Tc-99 is moving in the vadose zone.</p> <p>Elevated concentrations detected in Area 1 (Lysimeter Well PA03 and Cores I-4S and I-4D) and Area 3 (Lysimeter Well W23 and Cores I-IS, I-ID, and I-2D).</p>
U-233/234	<p>Elevated concentrations and trends in Areas 1 and 3 suggest uranium is moving in the vadose zone.</p> <p>Routine analysis and TIMS data confirm the presence of enriched uranium in mid-depth lysimeter Well TW1 (Area 1).</p> <p>Data from TIMS confirm the presence of depleted uranium in deep perched water Well 8802D (Area 1).</p>
U-235	<p>Elevated concentrations and trends in Areas 1 and 3 suggest uranium is moving in the vadose zone.</p> <p>Routine analysis and TIMS data confirm the presence of enriched uranium in mid-depth lysimeter Well TW1 (Area 1).</p> <p>Data from TIMS confirm the presence of depleted uranium in deep perched water Well 8802D (Area 1).</p>

Table 4-145. (continued).

Contaminant	Summary
U-238	<p>Elevated concentrations and trends in Areas 1 and 3 suggest U-238 is moving in the vadose zone.</p> <p>Routine analysis and TIMS data confirm the presence of enriched uranium in mid-depth lysimeter Well TW1 (Area 1).</p> <p>Data from TIMS confirm the presence of enriched uranium in the vicinity of lysimeter well TW1 (Area 1) and depleted uranium in deep perched water Well 8802D (Area 1).</p>
Nitrates	Most elevated nitrates are associated with shallow and mid-depth soil moisture samples collected in SDA areas 3 and 5.
CCl ₄	<p>CCl₄ is widely detected in the vadose zone in the vicinity of the SDA as determined from vapor sampling. The highest concentrations are found in the shallow and mid-depth vadose zone below the source areas shown in Figure 4-24. CCl₄ has been detected more than 1 km away from the SDA, but concentrations decrease significantly with distance away from the source areas. Deep soil gas concentrations (below the C-D interbed) are small compared to concentrations in the upper vadose zone, yet are capable of causing groundwater concentrations above maximum contaminant levels (MCLs).</p> <p>Organic contamination in the vadose zone vapor extraction operations have considerably decreased the levels of CCl₄ and other volatile organic compounds in the vadose zone.</p>

4.10.4 Discussion and Conclusions

Several contaminants (C-14, Tc-99 and uranium) have been detected in the vadose zone of the RWMC, and low concentrations of CCl₄, nitrates, and C-14 have also been detected in the aquifer. With the possible exception of CCl₄, no consistent trends are present in the vadose zone, and detections in the aquifer are sporadic.

The monitoring network has been greatly expanded since 1998 with 22 vadose zone lysimeters, 4 upgradient aquifer wells, an aquifer well inside the SDA, and Type A and B probes in the buried waste. In addition, analyte target lists have been modified to focus on those contaminants that may be migrating. Contaminants that pose an unacceptable risk (see Section 6) have been identified as a priority, especially for vadose zone samples where sample volumes are consistently small. Most of these changes have not been in place long enough to provide data necessary to refine our understanding of contaminant distribution or trends.

The expanded monitoring network and ongoing studies continue to produce data for assessing source release into the vadose zone, contaminant migration through the vadose zone, and potential impacts to the aquifer beneath the SDA. Until additional analyses are completed, the only conclusion that can be drawn is that contaminants have been detected sporadically at low concentrations in the vadose zone and in the aquifer. The mobile contaminants buried in the SDA have not impacted groundwater quality thus far, but as long as infiltration through the buried waste continues, contaminant migration is likely to continue. The impact of these contaminants can be assessed and validated through continued monitoring and careful interpretation of spatial and temporal patterns.

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